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INVESTIGATE THE COMBINATION OF COCONUT SHELL AND GRAINED PALM KERNEL TO REPLACE AGGREGATE IN CONCRETE: A TECHNICAL REVIEW

Siti Aminah Bt Tukiman and Sabarudin Bin Mohd

Faculty of Civil Engineering and Earth Resources, Universiti Malaysia Pahang, 26300 UMP, Kuantan, Pahang, Malaysia; Phone: +6013-9836296
Email: ahbab_tengku@yahoo.com, sabarudin@ump.edu.my

Corresponding Author: ahbab_tengku@yahoo.com

ABSTRACT

Conventional coarse aggregate namely gravel and fine aggregate is sand in concrete will be used as control. While natural material is coconut shell as course aggregate and grained palm kernel as fine aggregate will be investigate to replace the aggregate in concrete. In this studies, five different concrete mixes with different the combination of natural material content namely 0%,25%,50%,75% and 100%.Three sample specimen will be prepared for each concrete mixes. The parameters will be tested are flexural strength, compressive strength, tensile strength, modulus of elasticity, durability and deflection crack behavior. The effect of using different length of natural material aggregate will also investigate. The effect of aggregate content to workability will also examine. The expected outcome of the study is the combination of coconut shell and grained palm kernel shell has potential as lightweight aggregate in concrete. Also, using the combination of coconut shell and grained palm kernel as aggregate in concrete can reduce the material cost in construction because of the low cost and abundant agricultural waste.

Keywords: Coconut shell, Grained Palm Kernel shell, Aggregate, Coarse aggregate, Fine aggregate.

INTRODUCTION

There were many experimental work conducted to improve the properties of the concrete by putting new materials, whether it is natural materials or recycle materials or synthetic materials in the concrete mix. The additional material can be replacing the aggregate, cement or just as additive and one form of the additive is natural material. A large amount of agricultural waste was disposed in most of tropical countries especially in Asia for countries like Thailand, Philippine and Malaysia. If the waste cannot be disposed properly it will lead to social and environmental problem. The high cost of conventional building materials is a major factor affecting housing delivery in Malaysia. This has necessitated research into alternative materials of construction. There is an increasing interest in what happens to products at the end of their useful lives, so natural materials have an advantage in that they can biodegrade or be burnt in a carbon-neutral manner. Natural material like coconut shell and palm kernel shell are not commonly used in the construction industry but still are often dumped as agricultural wastes. However, with the quest for affordable housing system for both the rural and urban population of Malaysia and other developing countries, various proposals focusing on cutting down conventional building material costs

have been put forward. One of the suggestions in the forefront has been the sourcing, development and use of alternative, non-conventional local construction materials including the possibility of using some agricultural wastes and residues as construction materials. As the natural fibers are agriculture waste, manufacturing natural product is, therefore, an economic and interesting option. Coconuts show a wide diversity in size, weight, shape and color, depending on genetic variety and maturity of the nut at harvest (Ohler, 1999). Adeyemi, 1998 investigated, for one mix ratio (1:2:4) the suitability of coconut shell as substitute for either fine or coarse aggregate in concrete production. (Olanipekun et al., 2006) Investigated the comparative cost analysis and strength characteristics of concrete produced using crushed, granular coconut and Palm kernel shell as substitutes for conventional coarse aggregate. It was concluded that the coconut shell were suitable as low strength-giving lightweight aggregate when used to replace common coarse aggregate in concrete production.

EXPERIMENTAL PROGRAMME

The target of the experimental program was to determine the contribution of natural material aggregate type to the development of the strength behavior of the confined concrete. The experimental program comprises the following:

a. To investigate the best mix proportion of the combination of coconut shell as course aggregate and grained palm kernel as fine aggregate in concrete by the value of strength per weight ratio of sample specimen.
b. To investigate the feasibility of the combination of coconut shell as course aggregate and grained palm kernel as fine aggregate in concrete by determining its flexural, compressive strength, tensile strength, modulus of elasticity, post deflection behavior and durability.
c. To investigate the effect of the combination of coconut shell as course aggregate and grained palm kernel as fine aggregate in concrete content and length to the workability as lightweight aggregate in concrete and also the mechanical properties mentioned above.
d. To determine the optimum content of the combination of coconut shell as course aggregate and grained palm kernel as fine aggregate in concrete to improve the ductility and does not cause reduction the compressive strength.

RAW MATERIALS

Coconut shell as coarse aggregate

The coconut shells were obtained from a local coconut field located in Kampung Kurnia Kuantan Pahang. They were sun dried for 1 month before being crushed manually. The crushed materials were later transported to the laboratory where they were washed and allowed to dry under ambient temperature for another 1 month. The particle sizes of the coconut shell range from 5 to 20 mm.

Grained Palm Kernel as fine aggregate

Palm kernel shells were obtained was obtained in the already cracked and oil-extracted form, the fibrous outer parts of the nut already removed. It was kept indoors in sacks for 2 months. It was washed and graded in accordance with the British Standard methods of sampling, testing and sieve test of light weight aggregates for concrete. Other alternative, the shells were will obtained directly from any factory as palm kernel shell supplier .The palm kernel shell will be grain by the machine as fine aggregate. The particle diameter is 2.36 mm.

Other concrete mix components

Coarse aggregate

Coarse aggregates are materials retained on 5mm (3/16 inc) test sieve and containing only so much finer material as permitted from the various sizes as specified by MS 29:1995 and BS 410 and BS 882.Coarse aggregate may be described into three major part which are uncrushed gravel, crushed stone or crushed gravel and partially crushed gravel when it is the product of bending of uncrushed and crushed gravel. In this study, type sandstone having maximum size of 15 mm was used as coarse aggregates (Ing, 2008).

Sand (fine aggregate)

Sand may be described into two major parts, which are natural sand and crushed stone or crushing gravel sand. In this study, river sand and crushed sandstone with fineness modulus of 1.78 (Ing, 2008), that passed through a 2.36 mm BS 410 test sieve was used. The material used are having maximum particle size used was 2.36 mm diameter (Olanipekun, 2006). It must be clean and not contaminated by lumps of clay or coating of clay and also clean from salt ingredient. The concrete grade 30 will used and the detail of mixed proportion are shown in table. Water cement ratio was kept constant at 0.5.For mix ratios Cement: fine aggregate: coarse aggregate is 1:2:4

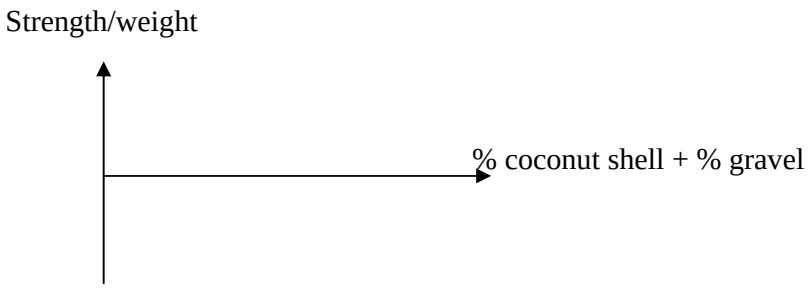
Table 1: Mix proportion of coconut shell in concrete

Mix Ratio	**1 (Cement) :**	**2(Fine Aggregate)**	**4(Course Aggregate)**
Control specimen	Cement	Sand	Gravel
Sample A	Cement	Sand	80% Gravel + 20% Coconut shell
Sample B	Cement	Sand	60% Gravel + 40% Coconut shell
Sample C	Cement	Sand	40% Gravel + 60% Coconut shell
Sample D	Cement	Sand	20% Gravel + 80% Coconut shell
Sample E	Cement	Sand	0% Gravel + 100% Coconut shell

The value of strength of the specimen will be determined and then the strength per weight value will be calculated. The graph percentage coarse aggregate versus strength/weight will be plot and then the best mix proportion of specimen was analyzed.

Table 2: The sample of the table for the strength/weight result values.

Sample	Strength(N/mm^2)	Weight (Kg)	Strength/weight
A	√	√	√
B	√	√	√
C	√	√	√
D	√	√	√
E	√	√	√



The best or the maximum value of specimen sample will be taken and the coarse aggregate content of the sample will be use for the next mix proportion experiment as the table below.
The coarse aggregate content namely as X.

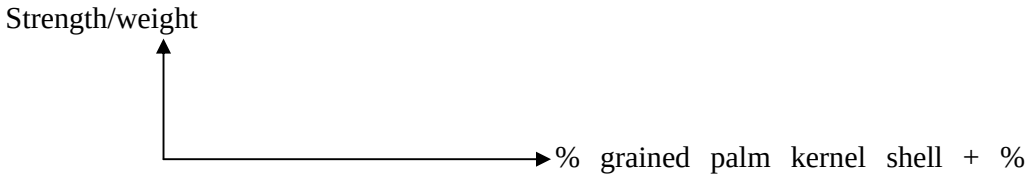
Table 3: Mix proportion of Grained Palm Kernel in concrete

Mix Ratio	**1 (Cement) :**	**2(Fine Aggregate) :**	**4(Course Aggregate)**
Sample A’	Cement	80% Sand + 20% Grained Palm Kernel shell	X
Sample B’	Cement	60% Sand + 40% Grained Palm Kernel shell	**X**
Sample C’	Cement	40% Sand + 60% Grained Palm Kernel shell	**X**
Sample D’	Cement	20% Sand + 80% Grained Palm Kernel shell	**X**
Sample E’	Cement	0% Sand + 100% Grained Palm Kernel shell	**X**

Plot the graph percentage fine aggregate versus strength/weight and then analyze the best mix proportion of specimen.

Table 4: The sample of the table for the strength/weight result values.

Sample	Strength(N/mm^2)	Weight (Kg)	Strength/weight
A'	√	√	√
B'	√	√	√
C'	√	√	√
D'	√	√	√
E'	√	√	√



The best or the maximum value of specimen sample will be taken and will be use for the next mix proportion experiment. The sample was choose is namely as SAMPLE Y (before the lab testing)

Preparation of specimen

At least 3 specimens will be prepared for each parameter to be tested. The specimens are prepared in accordance to BS 1881 Part 108:1983.The number of specimens will be prepared is shown in table.

Table 5: The numbers of concrete specimen test for natural material aggregate in concrete

SAMPLE Y		**Experiment**
Days	Number of specimen	
3	3	TENSILE TEST
7	3	
28	3	
3	3	FLEXURAL TEST
7	3	
28	3	
3	3	COMPRESSION TEST
7	3	
28	3	
		DURABILITY TEST
	12	
TOTAL	39	

The gravel aggregate in concrete also will be tested only for 1 sample for each experiment testing as control.

Table 6: Durability test specimen (continue durability test from Table 1)

SAMPLE Y	
Solution	**Number of specimen**
Sodium Hydroxide pH 12, 50g/l	3
Hydrochloride Acid pH 2, 20g/l	3
Sodium Chloride pH 8,20g/l	3
Water absorption	3
TOTAL SAMPLE	**12**

The gravel aggregate in concrete also will be tested for each experiment testing as control.

PROCEDURE

Experimental Plan

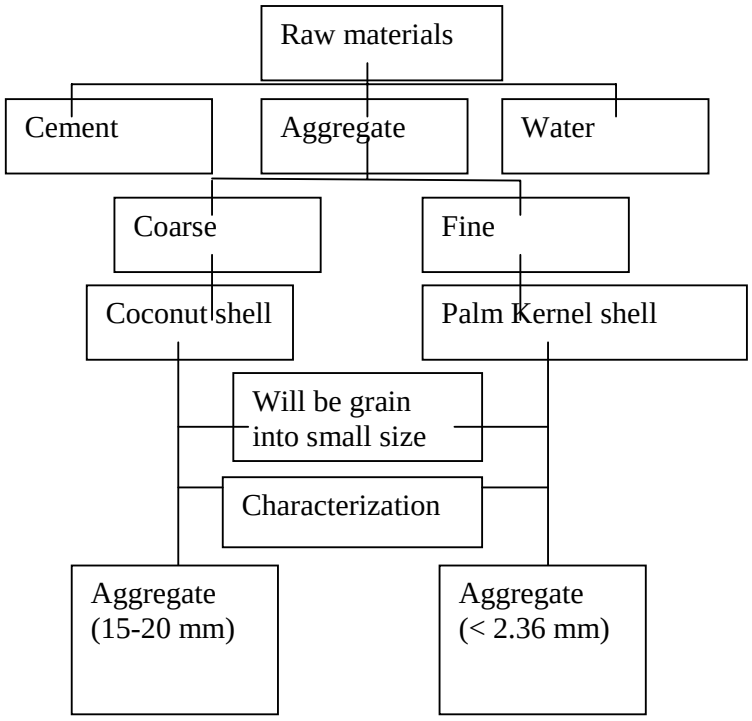


Figure 1: Flow chart of the raw material process

Figure 1 indicates the flowchart of the whole process of the raw material processes. The raw material consists of aggregate, ordinary Portland cement and water. The aggregate was divided into two types that are coarse aggregate and fine aggregate. The coarse aggregate consists of coconut shell and crushed stone whereas fine aggregate consists of grained palm kernel shell and normal sand. The ratio for each model was based on volumetric method. Figure 2 shows an experimental design for evaluating the effectiveness of five

different percentages on the performance of combination of coconut shell as coarse aggregate and grained palm kernel shell as fine aggregate.

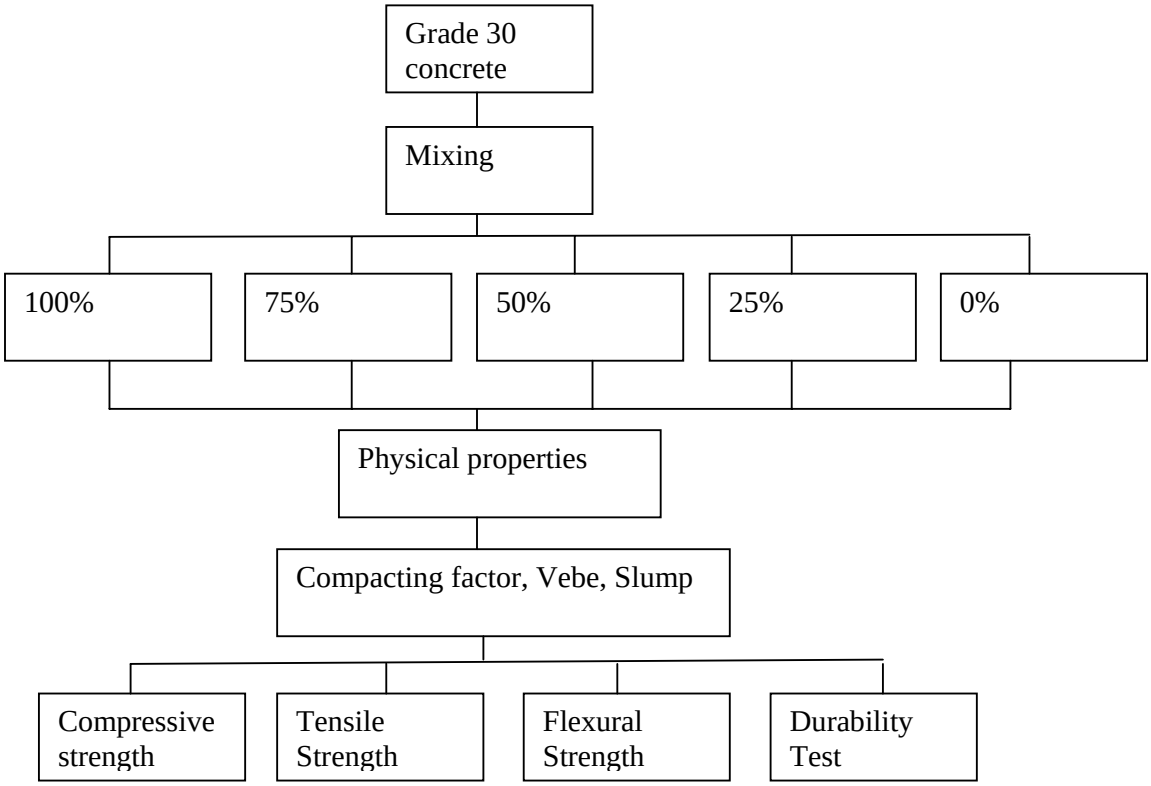


Figure 2: Flowchart of the concrete laboratory process

EXPECTED OUTCOME

Based on the literature review and research planning, the expected outcomes for the research are:

a) Olanipekun et al. (2006) were investigated the comparative cost analysis and strength characteristics of concrete produced using crushed, granular coconut and Palm kernel shell as substitutes for conventional coarse aggregate. The main objective is to encourage the use of these 'seemingly' waste products as construction materials in low-cost housing. It is also expected to serve the purpose of encouraging housing developers in investing in house construction incorporating these materials. The conclusions for the research are the compressive strength of the concrete decreased as the percentage shell substitution increased. In all cases, the Coconut shell concrete exhibited a higher compressive strength than Palm kernel shell concrete in the two mix proportion tested. Both types of concrete performed fairly equally well in terms of their water absorption capacities. In terms of cost, the Palm kernel shell concrete appears to be cheaper. However, considering the strength/economy ratio and expecting further studies on the durability performance of both types of shell concrete, it could reasonably be concluded that

Coconut shell would be more suitable than Palm kernel shell when used as substitute for conventional aggregates in concrete production

b) The results of this study from the literature review is the water absorption capacity of the coconut shell was obtained are low value 6.17%, it is reasonable to conclude that the shells absorb very little amount of mixing water during concrete production (Olanipekun, 2005) .The values are of coconut shell within the range of absorpt ion capacity of lightweight aggregates which have been put at 5–20% (Portland Cement Association).

c) Also, the percentage replacement levels of the conventional coarse aggregate with either coconut shell do not exceed 50%, for mix ratios tested. It showed that concrete obtained from coconut shell exhibited a higher compressive strength in the mix proportions. (Olanipekun, 2005).

d) Ogedengbe,1985; Nuhu-koko, 1999; Olateju,1992; Falade,1992; Omange,2001 and Ayangade et al., 2004 have shown that Palm kernel shell is suitable as granular filter for water treatment, as a suitable aggregate in plain, light and dense concretes and as a road building material.

e) Apart from its use in production of fibre-roofing material, the other possibility of using Coconut shell as an aggregate in concrete production has not been given any serious attention (Adeyemi, 1998) investigated, for one mix ratio (1:2:4) the suitability of Coconut shell as substitute for either fine or coarse aggregate in concrete production. It was concluded that the Coconut shell were more suitable as low strength-giving lightweight aggregate when used to replace common coarse aggregate in concrete production.

f) Also, from the observations, the combination of coconut shell and grained palm kernel shell has a potential as lightweight aggregate in concrete. Neville (1995) observed that lightweight concrete has a density in the range of 300–1850 kg/m3. This density range was obtained when 75% of the Coconut shells were used to replace gravel as coarse aggregate for mix ratios 1:1:2 and 1:2:4. This was also true for palm kernel shell concrete Palm kernel shell made from mix proportion 1:1:2. However, for the other mix ratio (1:2:4), lightweight concrete density range was achieved when 50% of the Palm kernel shell were used to replace gravel. The coconut shell concrete exhibited higher density than Palm kernel shell concrete. For both shells and for the two mix ratios, the density of the concrete decreased as the percentage of shells increased.

g) The combination of coconut shell and grained palm kernel shell to replace aggregate in concrete can produce the low cost building material in constructional market in Malaysia. It proved by the value of the shell as waste material in agriculture environment compare the aggregates like gravel, stone and sand that categories high cost in construction material because of the demand in the market.

h) The natural material as agricultural waste also can be handling by the development of high value product as replacing the aggregate in concrete. So, it can prevent the wasting problem in Malaysia.

i) The expected result from the cube strength test to determine the suitable sample is depend on the graph strength per weight versus the percentage aggregate content in concrete. Even though, the control sample have the highest strength in testing but the experimental also depend the weight of aggregate use in concrete .So the result of testing should be done first to answer the first objective in the research.

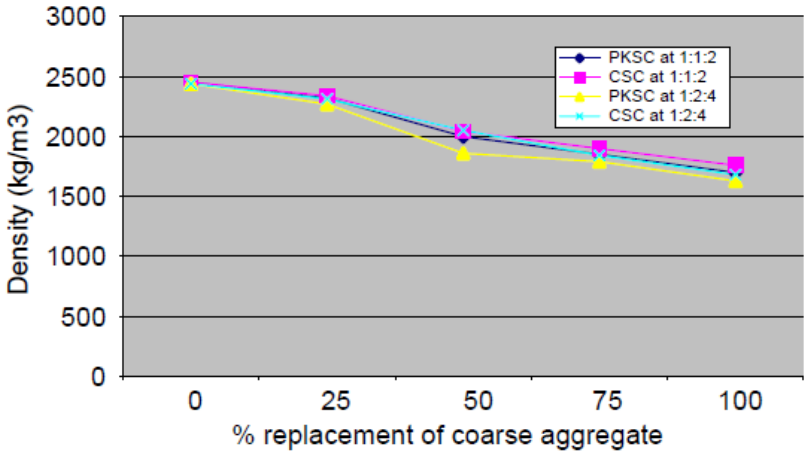


Figure 3: Density vs. % replacement at 1:1:2 and 1:2:4 mix proportions

CONCLUSION

From the experimental results and discussion, the combination of coconut shell and grained palm kernel shell has potential as lightweight aggregate in concrete. Also, using the combination of coconut shell and grained palm kernel shell as aggregate in concrete can reduce the material cost in construction because of the low cost and abundant agricultural waste.

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